

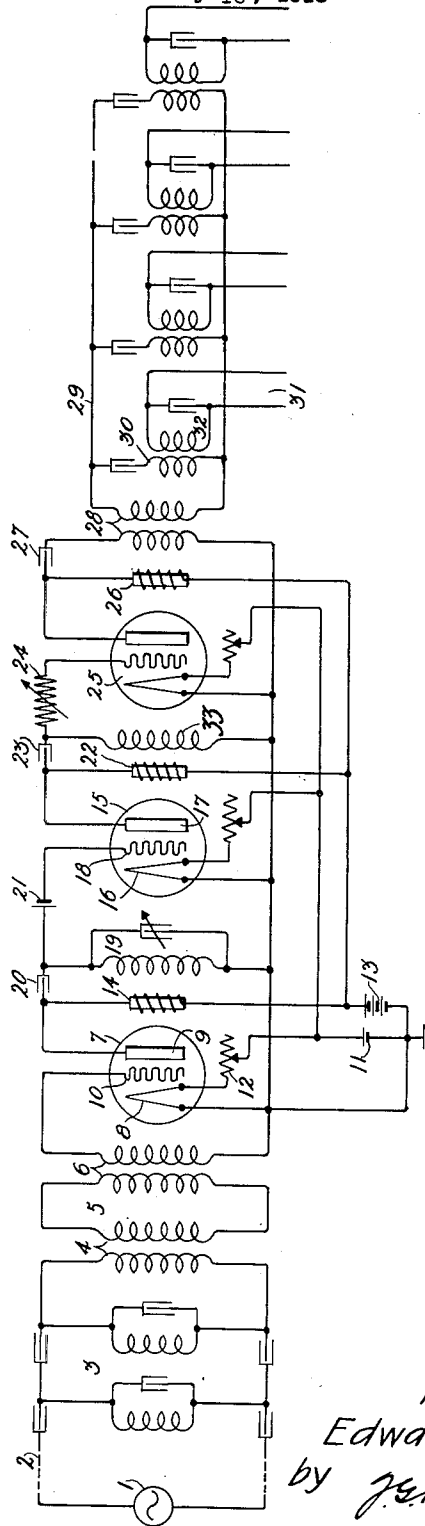
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METHOD OF AND MEANS FOR PRODUCING HARMONICS OF ALTERNATING CURRENTS

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METHOD OF AND MEANS FOR PRODUCING HARMONICS OF ALTERNATING CURRENTS.

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To all whom it may concern:

Be it known that I, EDWARD O. SCRIVEN, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Methods of and Means for Producing Harmonics of Alternating Currents, of which the following is a full, clear, concise, and exact description.

One feature of the invention relates to an arrangement of a high resistance in the input circuit of an electron discharge device to change its operating characteristics.

Another feature of the invention relates to an arrangement in which an electron relay is overloaded to distort the form of the impressed wave which it repeats.

A further feature of the invention relates to an arrangement in which a distorting repeater supplies an electromotive force to a second repeater sufficient to cause the latter to still further distort the original wave form.

An additional feature of the invention relates to the provision of means for controlling the relative amplitude of the harmonics produced by a distorting repeater.

According to the present invention there is impressed upon a repeating device an electromotive force of sinusoidal wave form and this wave form is so distorted by the device that it may be resolved into a series of sinusoidal components, the frequencies of which are the base and harmonics of the frequency of the impressed electromotive force. The distortion is accomplished, according to one method, by impressing upon the input circuit of a thermionic discharge device a sinusoidal electromotive force, the value of which is such that the conductivity of the discharge device at the maximum positive instantaneous electromotive force is greatly different from that at the maximum negative electromotive force. The output current of the thermionic discharge device will therefore have as a component a distorted or non-sinusoidal current which may be resolved into a fundamental frequency component and a series of sinusoidal harmonics. In order to select the various harmonics an arrangement of tuned circuits is used, each tuned circuit selecting its particular harmonic.

Referring to the drawing, which illus-

trates diagrammatically a circuit arrangement of a generator of harmonics according to the present invention, 1 represents a high frequency source which supplies alternating current of a base frequency to line 2 including a filter 3 to weed out harmonics, so that transformer 4 connected thereto transmits a substantially pure base frequency current to circuit 5, from which current of the base frequency is supplied to the input circuit of a thermionic amplifier 7 by a transformer 6, which steps up the voltage to a suitable value. Thermionic amplifier 7 comprises an evacuated container or tube including a hot filament 8 or other electron source, a plate or anode 9, and a grid or impedance controlling element 10. The input circuit includes the secondary winding of transformer 6, the terminals of which are connected to the grid 10 and filament 8. A current source 11 in series with the variable resistance 12 and filament 8 may be used to furnish heating current to the filament. A source 13 connected to filament 8 and plate 9, through a choke coil 14 supplies space current to the amplifier. Choke coil 14 excludes variation current components from this path. The amplified base frequency oscillations appearing in the output circuit of amplifier 7 are therefore impressed across the input circuit of a thermionic device or tube 15, which has a hot cathode 16, an anode or plate 17, and a grid 18. Bridged across the input circuit of tube 15 is a closed circuit 19 comprising an inductance and a variable capacity by means of which the closed circuit may be tuned to the base frequency and offer a substantially infinite impedance to currents of that frequency, and low impedance to any harmonics of that frequency which may have passed the wave filter 3. Blocking condenser 20, of large capacity, prevents flow of direct current from source 13, through the inductance of the tuned circuit, and a polarizing current source 21 fixes the initial impedance of tube 15 at the desired value. Sources 11 and 13 may furnish filament heating current and space current to thermionic device 15.

The base frequency electromotive force applied to the input circuit of tube 15 is sufficient to "overload" it, that is, the tube cannot faithfully repeat electromotive force variations of such high maximum ampli-

tudes as are applied. Under these circumstances the output current of tube 15 has as a component a base frequency current of distorted wave form. The choke coil 22 maintains substantially constant the direct current in the external space current path of tube 15 and the distorted base frequency current component is accordingly excluded from this path and supplied through a blocking condenser 23 of large capacity and a high variable resistance 24 to the input circuit of a second "over-loaded" tube 25, which may also be supplied with filament heating current and space current from sources 11 and 13 respectively. An inductance 33 shunted across the input circuit of tube 25 serves to accentuate the high harmonics for the reason that it offers a relatively low impedance shunt path to the base frequency and the lower harmonics, and accordingly permits a portion of them to pass around the higher internal input impedance of the tube, and at the same time offers a comparatively high impedance to the higher frequency currents. The variable resistance 24 serves to determine the relative amplitudes of the harmonics, since any grid current of any of the harmonic frequencies must flow through it.

The electrical action of tube 25 is substantially the same as that of tube 15 except that in addition, tube 25 serves to amplify harmonics supplied to its input circuit. The output circuit of tube 25 comprises a constant unidirectional current path through the choke coil 26 and a variation current path in parallel thereto including blocking condenser 27 of large capacity and the primary winding of a transformer 28, by which the harmonic currents produced are supplied to the circuit 29. A plurality of selecting circuits 30, each tuned to the frequency of a particular harmonic, are bridged across circuit 29 and each has a work circuit 31 associated therewith, by means of a closed loop 32 tuned to the particular harmonic selected, an inductance of the loop being coupled to an inductance of the selecting circuit.

Although the invention has been illustrated and described in connection with a specific circuit arrangement it is to be understood that it is not to be limited either to the specific arrangement as a whole, or to its particular details, but only by the scope of the appended claims.

What is claimed is:

1. Means for producing harmonics comprising an electron discharge device having an input circuit including a high resistance element, and means for overloading said device.

2. A circuit arrangement comprising two thermionic discharge devices connected in tandem and means connected therewith for

supplying single frequency oscillations of sufficiently high E. M. F. to overload both of said devices.

3. A circuit arrangement for producing harmonics of a base frequency current comprising an electron discharge device adapted when overloaded to distort the wave form of an impressed electromotive force and having an input circuit including a high resistance, and means for impressing an electromotive force upon said input circuit to overload said device.

4. An electron relay having an input circuit, a source of current connected to said circuit having an electromotive force sufficiently high to cause said relay to supply a repeated electromotive force of distorted wave form, and a closed tuned circuit bridged across said input circuit.

5. A thermionic repeater having an input circuit, a source of current connected thereto having an electromotive force of sufficient value to cause said repeater to distort its wave form in repeating, a high resistance in series with said source, and an impedance in shunt to said source.

6. In combination, an electron discharge device having an input circuit, means for supplying current of a base frequency and harmonics thereof to said input circuit, inductance in shunt to said means, and a resistance in series with said input circuit and located between the shunt inductance and said device.

7. In combination, a source of current, an electron discharge device, and an amplifier connecting said source to said device and serving to impress upon said device an electromotive force of such value that the variations of discharge current of said device are not proportional to the impressed electromotive force.

8. The method of operating an electron relay which comprises impressing upon it an electromotive force of distorted sine wave form and of such value that said relay cannot faithfully repeat the wave form of the impressed electromotive force, and selecting from its output circuit harmonics of the frequency of the impressed electromotive force.

9. The method of producing harmonics of a base frequency current which comprises distorting the wave form of a sinusoidal wave, regulating the relative amplitudes of the resulting harmonic and base frequency components, and further distorting the resultant wave form.

10. An electric discharge device having a cathode, an anode, and an impedance control element, an input circuit connecting said cathode and impedance control element, means connected to said input circuit for supplying electrical energy thereto of E. M. F. sufficiently high to overload said device,

and a high variable resistance in series in said input circuit and through which all of the input energy must flow whereby current traversing said input circuit may be regulated.

11. The method of producing harmonics of desired relative amplitudes by means of a plurality of wave distorting devices which comprises distorting energy of substantially sinusoidal wave form in one of said devices to secure energy of the same base frequency but of non-sinusoidal wave form, impeding the energy of the non-sinusoidal wave form in different degree for different frequencies and impressing the differently impeded energy upon another of said wave distorting devices in order to obtain harmonic frequency components of said base frequency of desired relative amplitudes.

12. The method of generating a plurality of frequencies which consists in impressing a fundamental frequency upon a translating device having a non-linear characteristic to produce harmonics of the fundamental frequency and in so transmitting harmonics thus produced as to cause the amplitude of the harmonics to approach equality.

13. In a system for the production of harmonics of a fundamental frequency, a translating arrangement having a non-linear

characteristic, a source having a fundamental frequency associated with said translating device for impressing energy thereon and an electrical network in the output circuit of said translating device to cause the amplitudes of the harmonics produced to approach the amplitude of the fundamental frequency.

14. In combination, an electron discharge device having an input circuit, an amplifier connected to said input circuit, means for supplying current of a base frequency and harmonics thereof to said input circuit, and a closed anti-resonant circuit tuned to the base frequency bridged across said input circuit.

15. In combination, a source of current, an electron discharge device having an input circuit, an amplifier connecting said source to said input circuit and serving to impress upon said device an electromotive force of such value that the variations of discharge current of said device are not proportional to the impressed electromotive force, and a closed anti-resonant circuit tuned to the frequency of said source of current bridged across said input circuit.

In witness whereof I hereunto subscribe my name this 8th day of July, A. D., 1918.

EDWARD O. SCRIVEN.